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Meteorus lucianae sp. nov. (Hymenoptera, Braconidae), a new parasitoid of the bud borer *Crocidosema aporema* (Lepidoptera, Tortricidae)

Luis Felipe Ventura de Almeida[1], Angélica Maria Penteado-Dias[1]

1 *Universidade Federal de São Carlos, Departamento de Ecologia e Biologia Evolutiva, Rod. Washington Luiz Km 235, São Carlos, SP, Brazil*

Corresponding author: Luis Felipe Ventura de Almeida (almeidalfvd@gmail.com)

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Abstract

Crocidosema aporema is a Neotropical Tortricidae moth that feeds on several wild and cultivated Fabaceae, and has a potential to cause economic damages. A new parasitoid wasp belonging to the genus *Meteorus* (Hymenoptera, Braconidae), which has been reared from *C. aporema* feeding on soybean in Brazil, is described and illustrated. A checklist of parasitoids previously recorded for *C. aporema* is provided.

Keywords

biological control, Brazil, *Epinotia*, taxonomy

Introduction

Crocidosema (=*Epinotia*) *aporema* (Walshingham) is a borer moth belonging to the family Tortricidae. It is widespread across Central and South America and can feed on several wild and cultivated Fabaceae, including alfalfa, broad bean, clover, common bean, lupin, melilot, peanut and soybean (Sanchez and Pereyra 2008). *Crocidosema aporema* is multivoltine and remains active year around, producing four to five generations (Sanchez et al. 1997).

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This species can be of economic importance for several crops. *Crocidosema aporema* has received particular attention as a pest of soybean, due to the importance of this crop in South America, where this insect can become a relevant problem especially in colder regions such as Argentina and the south of Brazil (Sanchez et al. 1997; Hoffmann-Campo et al. 2000). It is also considered one of the few insects regularly causing damage to fodder leguminosae in Uruguay, especially due to the impact to seed production (Alzugaray 2004).

The control of *C. aporema* using agrochemicals can be a twofold problem, first due to its borer behavior, which reduces the effectiveness of contact pesticides, second because *C. aporema* is more likely to impact crop productivity when present during the flowering stage, thus the use of insecticides during this critical phase could also affect pollinators (Foerster et al. 1983; Alzugaray 2004). Furthermore, the conspicuous plant damages caused by *C. aporema*, even when occurring below the economic threshold, are known to precipitate the use of insecticides by farmers and consequently increase economic and ecological costs (Bueno and Sosa-Gómez 2021). *Crocidosema aporema* has also been recorded developing on Bt soybean expressing the cry1Ac gene, indicating the existence of populations that have acquired some level of resistance to this particular protein (Bueno and Sosa-Gómez 2021).

Meteorus Haliday is a genus of endoparasitoid wasps belonging to the family Braconidae, it has a cosmopolitan distribution and around 350 described species (Yu et al. 2016). The genus has been recorded parasitizing a wide range of Lepidotera larvae, including several of economic relevance (Shaw 1997). The biology of *M. pulchricornis*, for instance, has been extensively studied and the species has been considered a potential biocontrol agent for major insect pests such as *Helicoverpa* spp. and *Spodoptera* spp. (Maeto 2018).

Biological control agents acting naturally or under an integrated pest management system could help maintain a more sustainable and productive cropping (Bortolotto et al. 2015). In this context, the present work aims to contribute to this goal by describing a novel parasitoid of *C. aporema* belonging to the genus *Meteorus*.

Materials and methods

The studied material is deposited at "Coleção Taxonômica do Departamento de Ecologia e Biologia Evolutiva da UFSCar" (DCBU), São Carlos, Brazil. Each examined specimen was given a unique collection catalog number (e.g. DCBU00000). Morphological terminology follows Sharkey and Wharton (1997), microsculpture terminology follows Harris (1979), measurements are taken as proposed by Aguirre et al. (2015). The description is based on the holotype and the variation found in paratypes is presented in parenthesis.

Images were obtained using a Leica DFC295 camera attached to a Leica M165C stereomicroscope and stacked with the Leica Application suite software v3.7.0. Pictures were later processed using Adobe Photoshop.

Results

***Meteorus lucianae* sp. nov.**
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Figs 1–7

Diagnosis. Dorsope absent; mandibles twisted; occipital carina complete; eyes large and convergent; head height 1.35–1.65 × eye height; face maximum width 1.24–1.55 × its minimum width; malar space length 0.40–0.62 × mandible width basally; ovipositor length 1.93–2.53 × first tergite length; ventral borders of T1 touching for a short distance or almost touching.

Description. ***Body length*:** 3.36 (2.93–4.05) mm.

***Color*:** Antenna dark brown with scape and pedicel yellow; head mostly yellow, frons and vertex medially black (sometimes frons mostly black, except by yellow patches around eyes); propleuron yellow; pronotum yellow ventrally, black dorsally; mesonotum black; mesopleuron dark brown-black with a yellow area on posterior margin (Fig. 1); metanotum dark brown; metapleuron dorsally dark brown, ventrally yellowish; propodeum black, with posterior margin yellow; prothoracic and mesothoracic legs yellow with telotarsus brown; metathoracic legs yellow with tibia and tarsus brown; T1 basal half brown, apical half black (T1 basally yellow, apically light brown); T2 and T7–T8 yellow, T3–T6 dark brown (Fig. 6); sterna yellow; wings hyaline.

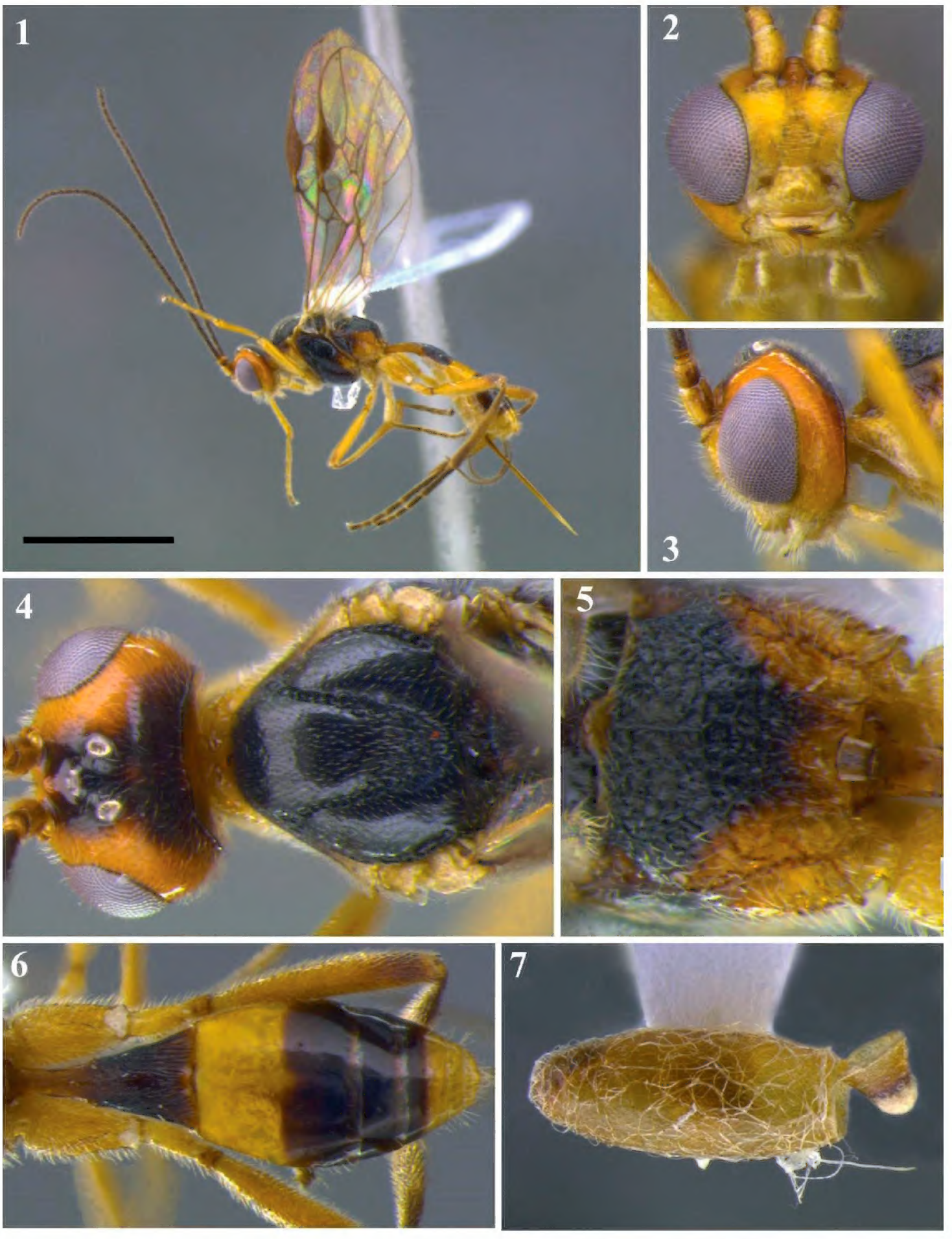
***Head*:** Antenna with 28 (27–29) flagellomeres; mandibles twisted; eyes not protuberant; occipital carina complete; vertex in dorsal view descending vertically behind the lateral ocelli; frons smooth, with a protuberance medially; face smooth, with a rugose area below the insertion of the antenna; clypeus rugulose with long hairs (Fig. 3); head width 1.27 (1.17–1.27) × its height; head height 1.35 (1.35–1.65) × eye height; face maximum width 1.44 (1.24–1.55) × its minimum width; face minimum width 1.25 (0.95–1.25) × clypeus width; minimum face width 1.04 (0.95–1.18) × face height; malar space length 0.60 (0.40–0.62) × mandible width basally; gena length 0.53 (0.40–0.59) × eye length in dorsal view; ocellus-ocular distance 1.37 (1.33–1.68) × ocellar diameter; ocellar diameter 0.67 (0.54–0.73) × posterior ocellar line (Fig. 4).

***Wings*:** Fore wing: length 2.93 (2.93–3.75) mm; vein m-cu postfurcal; length of vein r 0.42 (0.33–0.64) × vein 3Rsa; vein 3Rsa 0.67 (0.67–1.00) × length of vein r-m. Hind wing: vein 1M 1.51 (1.26–2.00) × length of vein cu-a; length of vein 1M 1.00 (1.00–1.78) × length of vein r-m.

***Mesosoma*:** Height 0.68 (0.65–0.68) × its length; propleuron smooth; pronotum mostly rugulose, carinate medially; central lobe of mesoscutum smooth; notauli distinctive and rugose, mesonotal lobes well defined (Fig. 4); scutelar sulcus with five (or three) carinae; mesopleuron smooth with a rugose area near tegula; precoxal sulcus long, carinate-rugose; metapleuron rugose; propodeum areolate-rugose without longitudinal or transversal carinae (longitudinal carinae visible in some specimens).

***Legs*:** Tarsal claw simple; hind coxa rugulose.

***Metasoma*:** Dorsope absent; first tergite with basal half smooth, apical half rugulose medially and costate laterally; remaining tergites smooth and shining; ventral



Figures 1–7. *Meteorus lucianae* sp. nov. **1** Lateral habitus **2** head, frontal view **3** head, lateral view **4** head and mesonotum, dorsal view **5** propodeum, dorsal view **6** metasoma, dorsal view **7** cocoon. Scale bar: 2 mm (**1**).

borders of first tergite touching for a short distance distally (or almost touching); ovipositor length 2.53 (1.93–2.53) × first tergite length (Fig. 1).

***Cocoon*:** Length 4.25 mm; width 1.53 mm; mostly honey–brown, translucent, and slightly covered by loose silk; apex cap protruding, whitish, and bordered by a dark ring (Fig. 7).

Examined material. ***Holotype*** Brazil • Female; Paraná, Lapa, Fazenda experimental IAPAR; 03 Feb.2016; A. C. Dudczak & A.M. Borba leg; DCBU 478005.

Paratypes Brazil• 1 Female; Idem holotype, except; 25 Feb. 2016.• 3 Females; Minas Gerais, Poços de Caldas, Sitio da Ferradura; 21°47'03"S, 46°37'23"W; 19 Apr. 2007; A. E. de Carvalho leg.; Malaise Trap; DCBU 09311, DCBU 09298 and DCBU 09294. • 1 Female; Idem previous, except,13 Dec.2007; DCBU 09899.• 1 Female; Rio de Janeiro, Itatiaia, Parque Nacional do Itatiaia; 22°26'01"S, 44°36'49"W; 30 May. 2014; R.F. Monteiro leg.; Malaise Trap; DCBU 78978.•1 Female; São Paulo, Campos do Jordão, Parque estadual de Campos do Jordão; 22°39'43"S, 45°27'2.8"W; 06 Nov. 2010; A. S. Soares leg.; Malaise Trap; DCBU 09112. • 1 Female; Sao Paulo, São Carlos, Fazenda Canchim; 31 Aug. 1983; A.S. Soares leg.; DCBU 478004 • 1 Female; São Paulo, Ribeirão Grande, Parque Estadual Intervales; 24°16'28"S, 48°25'19"W; 22 Nov. 2010; N.W. Perioto leg.; DCBU06906.• 1 Female; Minas Gerais, Bom Repouso, Serra dos Garcias; 22°29'25"S, 46°11'25"W; 17 Oct. 2009; I. F. Melo leg.; DCBU39826.

Additionally to the type series 87 specimens are deposited at DCBU (See Suppl. material 1 for detailed records).

Biology. The holotype of *Meteorus lucianae* sp. nov. was reared as a solitary parasitoid of *Crocidosema aporema* (Lepidoptera: Tortricidae) collected in soybean.

Distribution. Brazil (Paraná, Minas Gerais, São Paulo, Rio de Janeiro).

Etymology. *Meteorus lucianae* sp. nov. is named in honor of Luciana Bueno dos Reis Fernandes, recognizing the extensive technical support provided to the INCT Hympar Lab at the Federal University of São Carlos.

Discussion

Meteorus lucianae sp. nov. is morphologically most similar to *M. pseudodimidiatus* Zitani and would be identified as such in the key to Neotropical *Meteorus* presented in Aguirre et al. (2015). Nevertheless the new species can be separated from *M. pseudodimidiatus* especially by the differences on head and eye shape. This can be most easily identified by the ratio between the malar space length and the mandible width, which is 0.40–0.62 × in *M. lucianae* sp. nov., while 0.80–1.50 × in *M. pseudodimidiatus*. The new species also resembles *M. dimidiatus* (Cresson) but can be recognized by having a complete occipital carina and a shorter ovipositor, with its ovipositor length being 1.93–2.53 × the first tergite length (while *M. dimidiatus* has an incomplete carina and ovipositor length 2.60–2.80 × first tergite length).

When compared to the Paleartic fauna, *M. lucianae* sp. nov. is most similar to *M. tenellus* Marshall. Most notably these species share the lack of dorsope, a narrow

face, strongly twisted mandibles, frons with a median protuberance and ovipositor usually at least 2 times longer than the first tergite. Those shared morphological characteristics suggest that the new species could also belong to "Clade IIA" retrieved in the phylogenetic analysis presented in Stigenberg and Ronquist (2011). Similarly to the new species described here, *M. tenellus* and the closely related *M. cinctellus* (Spinola) have both been recorded utilizing Tortricidae hosts (Yu et al. 2016).

Currently the only known host association for the new species is the one here presented (*C. aporema* feeding on soybean). Nonetheless, it is noteworthy that several specimens studied were obtained from Malaise traps and were recorded in areas not typically associated with soybean production, including conservation areas. Is thus likely that in those areas the species is either utilizing *C. aporema* feeding in other Fabaceae or a different host species.

The genus *Meteorus* had not been recorded as a parasitoid of *C. aporema*, and in the Neotropics the use of Tortricidade as host is unusual in *Meteorus* (Aguirre et al. 2015). In contrast, several parasitoids from other taxonomic groups have been recorded using it as host, most belonging to the Hymenoptera superfamilies Chalcidoidea and Ichneumonoidea (Table 1).

The use of biological control agents such as parasitoids should be considered in managing pest insects as it represents a more sustainable alternative to the currently employed practices (Baker et al. 2020). Further investigation into this parasitoid autecology would be relevant to elucidate the factors affecting their natural occurrence. This in turn could be a relevant aid on conservation biological control programs, as well as providing new options for the integrated management of *C. aporema*.

Table 1. List of previously recorded parasitoids of *Crocidosema aporema* (Lepidoptera, Tortricidae).

Parasitoid	Reference
Order Hymenoptera	
Agathis sp. (Braconidae)	(Foerster and Calderón 1977)
Apanteles piceotrichosus Blanchard (Braconidae)	(Molinari and Monetti 1997)
Bassus sp. (Braconidae)	(Liljesthrom and Rojas-Fajardo 2005)
Bracon sp. (Braconidae)	(Liljesthrom and Rojas-Fajardo 2005)
Campoletis perdistinctus Viereck (Ichneumonidae)	(Sanchez and Pereyra 2008)
C. grioti Blanchard (Ichneumonidae)	(Molinari and Monetti 1997)
Chelonus sp. (Braconidae)	(Panizzi and Correa-Ferreira 1997)
Cotesia lesbiae (Blanchard) (Braconidae)	(Molinari and Monetti 1997)
Encarsia porter Mercet (Aphelinidae)	(Rojas 1968)
Goniozus nigrifemur Ashmead (Bethylidae)	(Panizzi and Correa-Ferreira 1997)
Itoplectis niobe Schrottky (Ichneumonidae)	(Zerbino and Alzugaray 1991)
Spilochalcis sp. (Chalcididae)	(De Santis and Monetti 2008)
Trathala sp. (Ichneumonidae)	(Liljesthrom and Rojas-Fajardo 2005)
Trichogrammatoidea bactrae Nagaraja (Trichogrammatidae)	(Whu and Valdivieso 1999)
Trichogramma pretiosum Riley (Trichogrammatidae)	(Basso et al. 2006)
T. brasiliensis (Ashmead) (Trichogrammatidae)	(Sanchez and Pereyra 2008)
Order Diptera	
Carcelia sp. (Tachinidae)	(Callohuari et al. 2018)
Eucelatoria australis Townsend (Tachinidae)	(Sanchez and Pereyra 2008)
Nemorilla ruficornis (Thompson) (Tachinidae)	(Panizzi and Correa-Ferreira 1997)

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Supplementary material 1

Table S1

Author: Luis Felipe Ventura de Almeida

Data type: Ocurrences.

Explanation note: Spreadsheet with ocurrence data of the examined material, deposited at DCBU (Coleção taxonomica do departmento do departamento de ecologia e biologia evolutiva da ufscar, Sao Carlos, Brazil).

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